

# DATA SHEET

## SURFACE MOUNT MULTILAYER CERAMIC CAPACITORS

General purpose & High capacitance

Class 2, X5R

4 V TO 50 V

100 pF to 220  $\mu$ F

RoHS compliant & Halogen free



SCOPE

This specification describes X5R series chip capacitors with lead-free terminations.

APPLICATIONS

PCs, Hard disk, Game PCs  
Power supplies  
DVD players  
Mobile phones  
Data processing

FEATURES

Supplied in tape on reel  
Nickel-barrier end termination  
RoHS compliant  
Halogen free compliant

ORDERING INFORMATION-GLOBAL PART NUMBER, PHYCOMP CTC & I2NC

All part numbers are identified by the series, size, tolerance, TC material, packing style, voltage, process code, termination and capacitance value.

**YAGEO BRAND ordering code**

**GLOBAL PART NUMBER (PREFERRED)**

**CC** xxxx x x **X5R** x **BB** xxx  
(1) (2) (3) (4) (5)

**(1) SIZE – INCH BASED (METRIC)**

0201 (0603)  
0402 (1005)  
0603 (1608)  
0805 (2012)  
1206 (3216)  
1210 (3225)

**(2) TOLERANCE**

K = ±10%  
M = ±20%

**(3) PACKING STYLE**

R = Paper/PE taping reel; Reel 7 inch  
K = Blister taping reel; Reel 7 inch  
P = Paper/PE taping reel; Reel 13 inch  
F = Blister taping reel; Reel 13 inch  
C = Bulk case

**(4) RATED VOLTAGE**

4 = 4 V  
5 = 6.3 V  
6 = 10 V  
7 = 16 V  
8 = 25 V  
9 = 50 V

**(5) CAPACITANCE VALUE**

2 significant digits+number of zeros  
The 3rd digit signifies the multiplying factor, and letter R is decimal point  
Example: 103 = 10 × 10<sup>3</sup> = 10,000 pF = 10 nF

**CONSTRUCTION**

The capacitor consists of a rectangular block of ceramic dielectric in which a number of interleaved metal electrodes are contained. This structure gives rise to a high capacitance per unit volume.

The inner electrodes are connected to the two end terminations and finally covered with a layer of plated tin (NiSn). The terminations are lead-free. A cross section of the structure is shown in Fig. 1.



Fig. 1 Surface mount multilayer ceramic capacitor construction

**DIMENSION**

| Table I For outlines see fig. 2 |                     |            |            | L <sub>2</sub> / L <sub>3</sub> (mm) |      | L <sub>4</sub> (mm) | DIMENSION CODE |
|---------------------------------|---------------------|------------|------------|--------------------------------------|------|---------------------|----------------|
| TYPE                            | L <sub>1</sub> (mm) | W (mm)     | T (MM)     | min.                                 | max. | min.                |                |
| 0201                            | 0.6 ±0.03           | 0.3 ±0.03  | 0.3 ±0.03  | 0.1                                  | 0.2  | 0.2                 | BA             |
|                                 | 0.6 ±0.05           | 0.3 ±0.05  | 0.3 ±0.05  | 0.1                                  | 0.2  | 0.2                 | BB             |
|                                 | 0.6 ±0.09           | 0.3 ±0.09  | 0.3 ±0.09  | 0.1                                  | 0.25 | 0.2                 | BC             |
|                                 | 0.6 ±0.15           | 0.3 ±0.15  | 0.3 ±0.15  | 0.1                                  | 0.25 | 0.2                 | BD             |
| 0402                            | 1.0 ±0.05           | 0.5 ±0.05  | 0.5 ±0.05  | 0.15                                 | 0.35 | 0.4                 | CA             |
|                                 | 1.0 ±0.10           | 0.5 ±0.10  | 0.5 ±0.10  | 0.15                                 | 0.35 | 0.4                 | CB             |
|                                 | 1.0 ±0.15           | 0.5 ±0.15  | 0.5 ±0.15  | 0.15                                 | 0.35 | 0.4                 | CC             |
|                                 | 1.0 ±0.20           | 0.5 ±0.20  | 0.5 ±0.20  | 0.15                                 | 0.35 | 0.4                 | CD             |
| 0603                            | 1.6 ±0.10           | 0.8 ±0.10  | 0.8 ±0.10  | 0.2                                  | 0.6  | 0.4                 | DA             |
|                                 | 1.6 ±0.15           | 0.8 ±0.15  | 0.8 ±0.15  | 0.2                                  | 0.6  | 0.4                 | DB             |
|                                 | 1.6 ±0.20           | 0.8 ±0.20  | 0.8 ±0.20  | 0.2                                  | 0.6  | 0.4                 | DC             |
| 0805                            | 2.0 ±0.20           | 1.25 ±0.20 | 0.85 ±0.10 | 0.25                                 | 0.75 | 0.7                 | EA             |
|                                 | 2.0 ±0.20           | 1.25 ±0.20 | 1.25 ±0.20 | 0.25                                 | 0.75 | 0.7                 | EB             |
| 1206                            | 3.2 ±0.15           | 1.6 ±0.15  | 1.15 ±0.10 | 0.25                                 | 0.75 | 1.4                 | FA             |
|                                 | 3.2 ±0.30           | 1.6 ±0.20  | 1.25 ±0.20 | 0.25                                 | 0.75 | 1.4                 | FB             |
|                                 | 3.2 ±0.30           | 1.6 ±0.30  | 1.60 ±0.20 | 0.25                                 | 0.80 | 1.4                 | FC             |
|                                 | 3.2 ±0.30           | 1.6 ±0.30  | 1.60 ±0.30 | 0.30                                 | 0.90 | 1.4                 | FD             |
| 1210                            | 3.2 ±0.40           | 2.5 ±0.30  | 1.25 ±0.20 | 0.25                                 | 0.75 | 1.4                 | GA             |
|                                 | 3.2 ±0.40           | 2.5 ±0.30  | 1.90 ±0.20 | 0.25                                 | 0.75 | 1.4                 | GB             |
|                                 | 3.2 ±0.40           | 2.5 ±0.30  | 2.5 ±0.20  | 0.25                                 | 0.75 | 1.0                 | GC             |
|                                 | 3.2 ±0.40           | 2.5 ±0.30  | 2.5 ±0.30  | 0.25                                 | 0.75 | 1.0                 | GD             |

**OUTLINES**



Fig. 2 Surface mount multilayer ceramic capacitor dimension

**CAPACITANCE RANGE & THICKNESS FOR X5R**

Table 2 Sizes from 0201 to 0402

| CAP.   | 0201 |       |      |      |      |      | 0402 |       |      |      |      |      |
|--------|------|-------|------|------|------|------|------|-------|------|------|------|------|
|        | 4 V  | 6.3 V | 10 V | 16 V | 25 V | 50 V | 4 V  | 6.3 V | 10 V | 16 V | 25 V | 50 V |
| 100 pF |      | BA    | BA   | BA   | BA   | BA   |      |       |      |      |      |      |
| 150 pF |      | BA    | BA   | BA   | BA   | BA   |      |       |      |      |      |      |
| 220 pF |      | BA    | BA   | BA   | BA   | BA   |      |       |      |      |      |      |
| 330 pF |      | BA    | BA   | BA   | BA   | BA   |      |       |      |      |      |      |
| 470 pF |      | BA    | BA   | BA   | BA   | BA   |      |       |      |      |      |      |
| 680 pF |      | BA    | BA   | BA   | BA   | BA   |      |       |      |      |      |      |
| 1.0 nF |      | BA    | BA   | BA   | BA   | BA   |      |       |      |      |      |      |
| 1.5 nF |      | BA    | BA   | BA   | BA   |      |      |       |      |      |      |      |
| 2.2 nF |      | BA    | BA   | BA   | BA   |      |      |       |      |      |      |      |
| 3.3 nF |      | BA    | BA   | BA   | BA   |      |      |       |      |      |      |      |
| 4.7 nF |      | BA    | BA   | BA   | BA   |      |      |       |      |      |      |      |
| 6.8 nF |      | BA    | BA   | BA   | BA   |      |      |       |      |      |      |      |
| 10 nF  |      | BA    | BA   | BA   | BA   |      |      |       |      |      |      |      |
| 15 nF  |      | BA    | BA   | BA   |      |      |      |       |      |      |      |      |
| 22 nF  |      | BA    | BA   | BA   | BA   |      |      | CA    | CA   | CA   | CA   | CA   |
| 33 nF  |      | BA    | BA   | BA   |      |      |      | CA    | CA   | CA   | CA   | CA   |
| 47 nF  |      | BA    | BA   | BA   |      |      |      | CA    | CA   | CA   | CA   | CA   |
| 68 nF  |      | BA    | BA   | BA   |      |      |      | CA    | CA   | CA   | CA   | CA   |
| 100 nF |      | BA    | BA   | BA   | BB   |      |      | CA    | CA   | CA   | CA   | CA   |
| 150 nF |      |       |      |      |      |      |      | CA    | CA   | CA   | CA   | CA   |
| 220 nF | BA   | BA    | BA   |      |      |      |      | CA    | CA   | CA   | CA   | CA   |
| 330 nF |      |       |      |      |      |      |      | CA    | CA   |      |      |      |
| 470 nF | BA   | BA    |      |      |      |      |      | CA    | CA   | CB   | CB   | CB   |
| 680 nF |      |       |      |      |      |      |      | CA    | CA   |      |      |      |
| 1.0 μF | BB   | BB    | BB   |      |      |      |      | CA    | CA   | CA   | CA   |      |
| 2.2 μF | BC   | BC    | BC   |      |      |      |      | CA    | CA   | CC   | CD   |      |
| 4.7 μF | BD   |       |      |      |      |      | CC   | CC    | CC   | CC   |      |      |
| 10 μF  |      |       |      |      |      |      | CD   | CD    | CD   |      |      |      |
| 22 μF  |      |       |      |      |      |      | CD   | CD    |      |      |      |      |

**NOTE**

1. Values in shaded cells indicate thickness class in mm
2. Capacitance value of non E-6 series is available on request

**CAPACITANCE RANGE & THICKNESS FOR X5R**

**Table 3** Sizes from 0603 to 0805

| CAP.   | 0603 |       |      |      |      |     | 0805 |          |          |          |          |     |
|--------|------|-------|------|------|------|-----|------|----------|----------|----------|----------|-----|
|        | 4V   | 6.3 V | 10 V | 16 V | 25 V | 50V | 4V   | 6.3 V    | 10 V     | 16 V     | 25 V     | 50V |
| 10 nF  |      |       |      |      |      |     |      |          |          |          |          |     |
| 15 nF  |      |       |      |      |      |     |      |          |          |          |          |     |
| 22 nF  |      |       |      |      |      |     |      |          |          |          |          |     |
| 33 nF  |      |       |      |      |      |     |      |          |          |          |          |     |
| 47nF   |      |       |      |      |      |     |      |          |          |          |          |     |
| 68 nF  |      |       |      |      |      |     |      |          |          |          |          |     |
| 100 nF |      |       |      |      |      |     |      |          |          |          |          |     |
| 150 nF |      |       |      |      |      |     |      |          |          |          |          |     |
| 220 nF |      | DA    | DA   | DA   | DA   | DA  |      |          |          |          |          |     |
| 330 nF |      | DA    | DA   | DA   | DA   | DA  |      |          |          |          |          |     |
| 470 nF |      | DA    | DA   | DA   | DA   | DA  |      | EA<br>EB | EA<br>EB | EA<br>EB | EB       | EB  |
| 680 nF |      | DA    | DA   | DA   | DA   | DA  |      | EA<br>EB | EA<br>EB | EA<br>EB | EB       | EB  |
| 1.0 μF |      | DA    | DA   | DA   | DA   | DA  |      | EA<br>EB | EA<br>EB | EA<br>EB | EB       | EB  |
| 2.2 μF |      | DA    | DA   | DA   | DB   | DC  |      | EA<br>EB | EA<br>EB | EA<br>EB | EA<br>EB | EB  |
| 4.7 μF |      | DA    | DA   | DB   | DB   |     |      | EA<br>EB | EA<br>EB | EB       | EB       | EB  |
| 10 μF  |      | DB    | DC   | DC   | DC   |     |      | EA<br>EB | EA<br>EB | EA<br>EB | EB       |     |
| 22 μF  |      | DC    | DC   |      |      |     |      | EB       | EB       | EB       | EB       |     |
| 47 μF  | DC   | DC    |      |      |      |     |      | EB       | EB       |          |          |     |
| 100 μF |      |       |      |      |      |     |      |          |          |          |          |     |

**NOTE**

1. Values in shaded cells indicate thickness class in mm
2. Capacitance value of non E-6 series is available on request

**Table 4** Sizes from 1206 to 1210

| CAP.   | 1206  |      |      |      |     | 1210  |      |      |      |     |
|--------|-------|------|------|------|-----|-------|------|------|------|-----|
|        | 6.3 V | 10 V | 16 V | 25 V | 50V | 6.3 V | 10 V | 16 V | 25 V | 50V |
| 10 nF  |       |      |      |      |     |       |      |      |      |     |
| 15 nF  |       |      |      |      |     |       |      |      |      |     |
| 22 nF  |       |      |      |      |     |       |      |      |      |     |
| 33 nF  |       |      |      |      |     |       |      |      |      |     |
| 47nF   |       |      |      |      |     |       |      |      |      |     |
| 68 nF  |       |      |      |      |     |       |      |      |      |     |
| 100 nF |       |      |      |      |     |       |      |      |      |     |
| 150 nF |       |      |      |      |     |       |      |      |      |     |
| 220 nF |       |      |      |      |     |       |      |      |      |     |
| 330 nF |       |      |      |      |     |       |      |      |      |     |
| 470 nF |       |      |      |      |     |       |      |      |      |     |
| 680 nF |       |      |      |      |     |       |      |      |      |     |
| 1.0 μF | FA    | FA   | FA   | FA   | FC  | GA    | GA   | GA   | GA   | GA  |
| 2.2 μF | FA    | FA   | FA   | FA   | FC  | GB    | GB   | GB   | GB   | GB  |
| 4.7 μF | FC    | FC   | FC   | FC   | FC  | GB    | GB   | GB   | GB   | GC  |
| 10 μF  | FC    | FC   | FC   | FC   | FD  | GB    | GB   | GB   | GB   | GD  |
| 22 μF  | FC    | FC   | FC   | FD   |     | GC    | GC   | GC   | GD   |     |
| 47 μF  | FC    | FC   | FD   |      |     | GC    | GC   | GC   |      |     |
| 100 μF | FD    |      |      |      |     | GD    | GD   | GD   |      |     |
| 220 μF |       |      |      |      |     | GD    |      |      |      |     |

**NOTE**

1. Values in shaded cells indicate thickness class in mm
2. Capacitance value of non E-6 series is available on request

**THICKNESS CLASSES AND PACKING QUANTITY**

Table 5

| SIZE CODE   | THICKNESS CLASSIFICATION | TAPE WIDTH QUANTITY PER REEL | Ø180 MM / 7 INCH |         | Ø330 MM / 13 INCH |         | QUANTITY PER BULK CASE |
|-------------|--------------------------|------------------------------|------------------|---------|-------------------|---------|------------------------|
|             |                          |                              | Paper            | Blister | Paper             | Blister |                        |
| 0201        | 0.3 ±0.03 mm             | 8 mm                         | 15,000           | ---     | 50,000            | ---     | ---                    |
| 0402        | 0.5 ±0.05 / 0.1 mm       | 8 mm                         | 10,000           | ---     | 50,000            | ---     | 50,000                 |
|             | 0.5 ±0.15 / 0.2 mm       | 8 mm                         | 10,000           | ---     | 40,000            | ---     | ---                    |
| 0603        | 0.8 ±0.1 mm              | 8 mm                         | 4,000            | ---     | 15,000            | ---     | 15,000                 |
| 0805        | 0.6 ±0.1 mm              | 8 mm                         | 4,000            | ---     | 20,000            | ---     | 10,000                 |
|             | 0.85 ±0.1 mm             | 8 mm                         | 4,000            | ---     | 15,000            | ---     | 8,000                  |
|             | 1.25 ±0.2 mm             | 8 mm                         | ---              | 3,000   | ---               | 10,000  | 5,000                  |
| 1206        | 0.6 ±0.1 mm              | 8 mm                         | 4,000            | ---     | 20,000            | ---     | ---                    |
|             | 0.85 ±0.1 mm             | 8 mm                         | 4,000            | ---     | 15,000            | ---     | ---                    |
|             | 1.00 / 1.15 ±0.1 mm      | 8 mm                         | ---              | 3,000   | ---               | 10,000  | ---                    |
|             | 1.25 ±0.2 mm             | 8 mm                         | ---              | 3,000   | ---               | 10,000  | ---                    |
|             | 1.6 ±0.15 mm             | 8 mm                         | ---              | 2,500   | ---               | 10,000  | ---                    |
| 1210        | 1.6 ±0.2 mm              | 8 mm                         | ---              | 2,000   | ---               | 8,000   | ---                    |
|             | 0.6 / 0.7 ±0.1 mm        | 8 mm                         | ---              | 4,000   | ---               | 15,000  | ---                    |
|             | 0.85 ±0.1 mm             | 8 mm                         | ---              | 4,000   | ---               | 10,000  | ---                    |
|             | 1.15 ±0.1 mm             | 8 mm                         | ---              | 3,000   | ---               | 10,000  | ---                    |
|             | 1.15 ±0.15 mm            | 8 mm                         | ---              | 3,000   | ---               | 10,000  | ---                    |
|             | 1.25 ±0.2 mm             | 8 mm                         | ---              | 3,000   | ---               | ---     | ---                    |
|             | 1.5 ±0.1 mm              | 8 mm                         | ---              | 2,000   | ---               | ---     | ---                    |
|             | 1.6 / 1.9 ±0.2 mm        | 8 mm                         | ---              | 2,000   | ---               | ---     | ---                    |
| 2.0 ±0.2 mm | 8 mm                     | ---                          | 2,000<br>1,000   | ---     | ---               | ---     |                        |
| 2.5 ±0.2 mm | 8 mm                     | ---                          | 1,000<br>500     | ---     | ---               | ---     |                        |

**ELECTRICAL CHARACTERISTICS**

**X5R DIELECTRIC CAPACITORS; NISN TERMINATIONS**

Unless otherwise specified, all tests and measurements shall be made under standard atmospheric conditions for testing as given in 5.3 of IEC 60068-1:

- Temperature: 15 °C to 35 °C
- Relative humidity: 25% to 75%
- Air pressure: 86 kPa to 106 kPa

Before the measurements are made, the capacitor shall be stored at the measuring temperature for a time sufficient to allow the entire capacitor to reach this temperature.

The period as prescribed for recovery at the end of a test is normally sufficient for this purpose.

Table 6

| DESCRIPTION   |                    |                |                |                |              |               | VALUE   |
|---|--------------------|----------------|----------------|----------------|--------------|---------------|---|
| Capacitance range   |                    |                |                |                |              |               | 100 pF to 220 μF  |
| Capacitance tolerance   |                    |                |                |                |              |               | ±10% and ±20%   |
| Dissipation factor (D.F.)   |                    |                |                |                |              |               |   |
| X5R   | 0201               | 0402           | 0603           | 0805           | 1206         | 1210          | D.F.  |
| ≤ 6.3V  | 100pF to 10nF      | 22nF to 100nF  | 220nF to 1μF   | 470nF to 680nF | 1μF to 10μF  | 1μF to 10μF   | ≤ 5%  |
|   |                    | 120nF to 220nF |                |                |              | 22μF          | ≤ 7%  |
|   | 12nF to 1μF        | 330nF to 10μF  | 2.2μF to 47μF  | 1μF to 100μF   | 22μF to 47μF | 47μF to 220μF | ≤ 10%   |
|   | 2.2μF              |                |                |                | 100μF, 220μF |               | ≤ 15%   |
|   | 4.7μF              | 22μF           |                |                |              |               | ≤ 20%   |
| 10V   | 100pF to 10nF      | 22nF to 100nF  | 220nF to 470nF | 470nF to 680nF | 1μF to 4.7μF | 1μF to 4.7μF  | ≤ 5%  |
|   |                    | 120nF to 220nF | 680nF          | 1μF            |              |               | ≤ 7%  |
|   | 12nF to 220nF, 1μF | 330nF to 10μF  | 1μF to 22μF    | 2.2μF to 47μF  | 10μF to 47μF | 10μF to 100μF | ≤ 10%   |
|   | 470nF              |                |                |                |              |               | ≤ 15%   |
|   | 2.2μF              |                |                |                |              |               | ≤ 20%   |
| 16V   | 100pF to 10nF      | 22nF to 100nF  | 220nF to 470nF | 470nF to 680nF | 1μF to 4.7μF | 1μF to 4.7μF  | ≤ 5%  |
|   |                    | 120nF to 220nF | 680nF to 1μF   | 1μF to 2.2μF   |              |               | ≤ 7%  |
|   | 12nF to 220nF      | 470nF to 4.7μF | 2.2μF to 10μF  | 4.7μF to 22μF  | 10μF to 47μF | 10μF to 100μF | ≤ 10%   |
|   | 470nF              |                |                |                |              |               | ≤ 20%   |
|   |                    |                |                |                |              |               |   |
| 25V   | 100pF to 470pF     | 22nF           |                | 470nF to 1μF   | 1μF to 2.2μF | 1μF to 4.7μF  | ≤ 3.5%  |
|   | 560pF to 10nF      | 27nF to 100nF  | 220nF to 470nF | 2.2μF          | 4.7μF        | 10μF          | ≤ 5%  |
|   |                    | 120nF to 220nF | 680nF to 1μF   |                |              |               | ≤ 7%  |
|   | 22nF, 100nF        | 470nF to 2.2μF | 2.2μF to 10μF  | 4.7μF to 22μF  | 10μF to 22μF | 22μF          | ≤ 10%   |
|   |                    |                |                |                |              |               |   |
| 50V   | 100pF to 1nF       | 22nF           |                |                |              |               | ≤ 3.5%  |
|   |                    | 27nF to 120nF  |                |                |              |               | ≤ 5%  |
|   |                    | 150nF to 220nF |                |                |              |               | ≤ 7%  |
|   |                    | 470nF          | 220nF to 2.2μF | 470nF to 10μF  | 1μF to 10μF  | 1μF to 10μF   | ≤ 10%   |
|   |                    |                |                |                |              |               |   |
| Insulation resistance after 1 minute at Ur (DC)   |                    |                |                |                |              |               | Rins ≥ 10 GΩ or Rins × Cr ≥ 50/100/500* seconds whichever is less |
| Maximum capacitance change as a function of temperature (temperature characteristic/coefficient): |                    |                |                |                |              |               | ±15%  |
| Operating temperature range:  |                    |                |                |                |              |               | -55 °C to +85 °C  |



**NOTE**

\* Rins  $\geq$  10 G $\Omega$  or Rins  $\times$  Cr  $\geq$  500 $\Omega$ .F:

0201 : 100pF to 47nF

0402 : 22nF to 470nF

0603 : 220nF to 1 $\mu$ F

0805 : 470nF to 2.2 $\mu$ F, 4.7 $\mu$ F/6.3V to 10V

1206 : 1 $\mu$ F to 2.2 $\mu$ F, 4.7 $\mu$ F/6.3V to 10V

1210 : 1 $\mu$ F to 2.2 $\mu$ F, 4.7 $\mu$ F/6.3V to 16V

\* Rins  $\times$  Cr  $\geq$  100 $\Omega$ .F:

0201 : 100nF to 470nF

0402 : 1 $\mu$ F to 4.7 $\mu$ F

0603 : 2.2 $\mu$ F to 4.7 $\mu$ F

0805 : 4.7 $\mu$ F/16V to 50V, 10 $\mu$ F to 22 $\mu$ F/4V to 25V

1206 : 4.7 $\mu$ F/16V to 50V, 10 $\mu$ F to 47 $\mu$ F

1210 : 4.7 $\mu$ F/25V to 50V, 10 $\mu$ F to 220 $\mu$ F

\* Rins  $\times$  Cr  $\geq$  50 $\Omega$ .F:

0201 : 1 $\mu$ F

0402 : 10 $\mu$ F

0603 : 10 $\mu$ F to 22 $\mu$ F

0805 : 10 $\mu$ F/50V, 47 $\mu$ F to 100 $\mu$ F

1206 : 100 $\mu$ F, 220 $\mu$ F

\* Rins  $\times$  Cr  $\geq$  20 $\Omega$ .F:

0201 : 2.2 $\mu$ F to 4.7 $\mu$ F

0402 : 22 $\mu$ F

0603 : 47 $\mu$ F



**Fig. 3** Typical capacitance change as a function of temperature

Size 0201 10 nF / 16 V  
Solid lines: Impedance / Dotted lines: ESR



**Fig. 4** Impedance ESR vs. frequency characteristics for multilayer chip capacitors

Size 0603 1 μF / 10 V  
Solid lines: Impedance / Dotted lines: ESR



**Fig. 5** Impedance ESR vs. frequency characteristics for multilayer chip capacitors

Size 0805 10  $\mu$ F / 6.3 V  
 Solid lines: Impedance / Dotted lines: ESR



**Fig. 6** Impedance ESR vs. frequency characteristics for multilayer chip capacitors

Size 1206 10  $\mu$ F / 16 V  
 Solid lines: Impedance / Dotted lines: ESR



**Fig. 7** Impedance ESR vs. frequency characteristics for multilayer chip capacitors

Size 1210 10  $\mu$ F / 25 V  
 Solid lines: Impedance / Dotted lines: ESR



**Fig. 8** Impedance ESR vs. frequency characteristics for multilayer chip capacitors

**SOLDERING RECOMMENDATION**

Table 7

| SOLDERING METHOD | SIZE        | 0402          | 0603             | 0805               | 1206               | $\geq$ 1210 |
|------------------|-------------|---------------|------------------|--------------------|--------------------|-------------|
|                  | 0201        |               |                  |                    |                    |             |
| Reflow           | Reflow only | > 100 nF      | > 1 $\mu$ F      | > 2.2 $\mu$ F      | > 2.2 $\mu$ F      | Reflow only |
| Reflow/Wave      |             | $\leq$ 100 nF | $\leq$ 1 $\mu$ F | $\leq$ 2.2 $\mu$ F | $\leq$ 2.2 $\mu$ F | ---         |

**TESTS AND REQUIREMENTS**
**Table 8** Test procedures and requirements

| TEST                                     | TEST METHOD         | PROCEDURE  | REQUIREMENTS                     |
|--|---------------------|--|----------------------------------|
| Mounting                                 | IEC 60384-21/22 4.3 | The capacitors may be mounted on printed-circuit boards or ceramic substrates  | No visible damage                |
| Visual Inspection and Dimension Check    | 4.4                 | Any applicable method using $\times 10$ magnification  | In accordance with specification |
| Capacitance <sup>(1)</sup>               | 4.5.1               | Class 2:   | Within specified tolerance       |
| Dissipation Factor (D.F.) <sup>(1)</sup> | 4.5.2               | At 20 °C, 24 hrs after annealing<br>Cap $\leq 1 \mu\text{F}$ , $f = 1 \text{ KHz}$ , measuring at voltage $1 \text{ V}_{\text{rms}}$ at 20 °C<br>Cap $> 1 \mu\text{F}$ , $f = 1 \text{ KHz}$ for C $\leq 10 \mu\text{F}$ , rated voltage $> 6.3 \text{ V}$ , measuring at voltage $1 \text{ V}_{\text{rms}}$ at 20 °C<br>$f = 1 \text{ KHz}$ , for C $\leq 10 \mu\text{F}$ , rated voltage $\leq 6.3 \text{ V}$ , measuring at voltage $0.5 \text{ V}_{\text{rms}}$ at 20 °C<br>$f = 120 \text{ Hz}$ for C $> 10 \mu\text{F}$ , measuring at voltage $0.5 \text{ V}_{\text{rms}}$ at 20 °C |                                  |
| Insulation Resistance                    | 4.5.3               | At $U_r$ (DC) for 1 minute   | In accordance with specification |

**NOTE**

1. The figure indicates typical inspection. Please refer to individual specifications.

| TEST                       | TEST METHOD           | PROCEDURE  | REQUIREMENTS   |                 |               |      |   |                       |   |      |      |                       |     |      |   |     |     |     |      |     |     |     |      |     |     |      |      |     |     |      |      |     |     |     |
|----------------------------|-----------------------|--|--|-----------------|---------------|------|---|-----------------------|---|------|------|-----------------------|-----|------|---|-----|-----|-----|------|-----|-----|-----|------|-----|-----|------|------|-----|-----|------|------|-----|-----|-----|
| Temperature Characteristic | 4.6                   | <p>Capacitance shall be measured by the steps shown in the following table.</p> <p>The capacitance change should be measured after 5 min at each specified temperature stage.</p> <table border="1" style="margin-left: 20px; border-collapse: collapse;"> <thead> <tr> <th>Step</th> <th>Temperature(°C)</th> </tr> </thead> <tbody> <tr> <td>a</td> <td>25±2</td> </tr> <tr> <td>b</td> <td>Lower temperature±3°C</td> </tr> <tr> <td>c</td> <td>25±2</td> </tr> <tr> <td>d</td> <td>Upper Temperature±2°C</td> </tr> <tr> <td>e</td> <td>25±2</td> </tr> </tbody> </table> <p>(1) Class I</p> <p>Temperature Coefficient shall be calculated from the formula as below</p> $\text{Temp. Coefficient} = \frac{C2 - C1}{C1 \times \Delta T} \times 10^6 \text{ [ppm/°C]}$ <p>C1: Capacitance at step c<br/>C2: Capacitance at 125°C<br/>ΔT: 100°C(=125°C-25°C)</p> <p>(2) Class II</p> <p>Capacitance Change shall be calculated from the formula as below</p> $\Delta C = \frac{C2 - C1}{C1} \times 100\%$ <p>C1: Capacitance at step c<br/>C2: Capacitance at step b or d</p> | Step   | Temperature(°C) | a             | 25±2 | b | Lower temperature±3°C | c | 25±2 | d    | Upper Temperature±2°C | e   | 25±2 | <p>&lt;General purpose series&gt;</p> <p>Class1:<br/>Δ C/C: ±30ppm</p> <p>Class2:<br/>X7R: Δ C/C: ±15%<br/>Y5V: Δ C/C: 22~-82%</p> <p>&lt;High Capacitance series&gt;</p> <p>Class2:<br/>X7R/X5R: Δ C/C: ±15%<br/>Y5V: Δ C/C: 22~-82%</p> |     |     |     |      |     |     |     |      |     |     |      |      |     |     |      |      |     |     |     |
| Step                       | Temperature(°C)       |  |  |                 |               |      |   |                       |   |      |      |                       |     |      |   |     |     |     |      |     |     |     |      |     |     |      |      |     |     |      |      |     |     |     |
| a                          | 25±2                  |  |  |                 |               |      |   |                       |   |      |      |                       |     |      |   |     |     |     |      |     |     |     |      |     |     |      |      |     |     |      |      |     |     |     |
| b                          | Lower temperature±3°C |  |  |                 |               |      |   |                       |   |      |      |                       |     |      |   |     |     |     |      |     |     |     |      |     |     |      |      |     |     |      |      |     |     |     |
| c                          | 25±2                  |  |  |                 |               |      |   |                       |   |      |      |                       |     |      |   |     |     |     |      |     |     |     |      |     |     |      |      |     |     |      |      |     |     |     |
| d                          | Upper Temperature±2°C |  |  |                 |               |      |   |                       |   |      |      |                       |     |      |   |     |     |     |      |     |     |     |      |     |     |      |      |     |     |      |      |     |     |     |
| e                          | 25±2                  |  |  |                 |               |      |   |                       |   |      |      |                       |     |      |   |     |     |     |      |     |     |     |      |     |     |      |      |     |     |      |      |     |     |     |
| Adhesion                   | 4.7                   | <p>A force applied for 10 seconds to the line joining the terminations and in a plane parallel to the substrate</p>  | <p>Force</p> <p>size ≥ 0603: 5N<br/>size = 0402: 2.5N<br/>size = 0201: 1N</p>  |                 |               |      |   |                       |   |      |      |                       |     |      |   |     |     |     |      |     |     |     |      |     |     |      |      |     |     |      |      |     |     |     |
| Bending Strength           | IEC 60384-21/22 4.8   | <p>Mounting in accordance with IEC 60384-22 paragraph 4.3</p> <p>Conditions: bending 1 mm at a rate of 1 mm/s, radius jig 5 mm</p> <p><b>Test Substrate:</b></p>    | <p>ΔC/C</p> <p>Class2:</p> <p>&lt;General purpose series&gt;</p> <p>X5R: ±10%</p> <p>&lt;High Capacitance series&gt;</p> <p>X5R: ±12.5%</p> <table border="1" style="margin-left: 20px; border-collapse: collapse;"> <thead> <tr> <th rowspan="2">Type</th> <th colspan="3">Dimension(mm)</th> </tr> <tr> <th>a</th> <th>b</th> <th>c</th> </tr> </thead> <tbody> <tr> <td>0201</td> <td>0.3</td> <td>0.9</td> <td>0.3</td> </tr> <tr> <td>0402</td> <td>0.4</td> <td>1.5</td> <td>0.5</td> </tr> <tr> <td>0603</td> <td>1.0</td> <td>3.0</td> <td>1.2</td> </tr> <tr> <td>0805</td> <td>1.2</td> <td>4.0</td> <td>1.65</td> </tr> <tr> <td>1206</td> <td>2.2</td> <td>5.0</td> <td>1.65</td> </tr> <tr> <td>1210</td> <td>2.2</td> <td>5.0</td> <td>2.0</td> </tr> </tbody> </table> <p style="text-align: right;">Unit: mm</p> | Type            | Dimension(mm) |      |   | a                     | b | c    | 0201 | 0.3                   | 0.9 | 0.3  | 0402  | 0.4 | 1.5 | 0.5 | 0603 | 1.0 | 3.0 | 1.2 | 0805 | 1.2 | 4.0 | 1.65 | 1206 | 2.2 | 5.0 | 1.65 | 1210 | 2.2 | 5.0 | 2.0 |
| Type                       | Dimension(mm)         |  |  |                 |               |      |   |                       |   |      |      |                       |     |      |   |     |     |     |      |     |     |     |      |     |     |      |      |     |     |      |      |     |     |     |
|                            | a                     | b  | c  |                 |               |      |   |                       |   |      |      |                       |     |      |   |     |     |     |      |     |     |     |      |     |     |      |      |     |     |      |      |     |     |     |
| 0201                       | 0.3                   | 0.9  | 0.3  |                 |               |      |   |                       |   |      |      |                       |     |      |   |     |     |     |      |     |     |     |      |     |     |      |      |     |     |      |      |     |     |     |
| 0402                       | 0.4                   | 1.5  | 0.5  |                 |               |      |   |                       |   |      |      |                       |     |      |   |     |     |     |      |     |     |     |      |     |     |      |      |     |     |      |      |     |     |     |
| 0603                       | 1.0                   | 3.0  | 1.2  |                 |               |      |   |                       |   |      |      |                       |     |      |   |     |     |     |      |     |     |     |      |     |     |      |      |     |     |      |      |     |     |     |
| 0805                       | 1.2                   | 4.0  | 1.65   |                 |               |      |   |                       |   |      |      |                       |     |      |   |     |     |     |      |     |     |     |      |     |     |      |      |     |     |      |      |     |     |     |
| 1206                       | 2.2                   | 5.0  | 1.65   |                 |               |      |   |                       |   |      |      |                       |     |      |   |     |     |     |      |     |     |     |      |     |     |      |      |     |     |      |      |     |     |     |
| 1210                       | 2.2                   | 5.0  | 2.0  |                 |               |      |   |                       |   |      |      |                       |     |      |   |     |     |     |      |     |     |     |      |     |     |      |      |     |     |      |      |     |     |     |

| TEST                         | TEST METHOD             | PROCEDURE  | REQUIREMENTS  |
|------------------------------|-------------------------|--|---|
| Resistance to Soldering Heat | 4.9                     | <p>Precondition: 150 +0/-10 °C for 1 hour, then keep for 24 ±1 hours at room temperature</p> <p>Preheating: for size ≤ 1206: 120 °C to 150 °C for 1 minute</p> <p>Preheating: for size &gt; 1206: 100 °C to 120 °C for 1 minute and 170 °C to 200 °C for 1 minute</p> <p>Solder bath temperature: 260 ±5 °C</p> <p>Dipping time: 10 ±0.5 seconds</p> <p>Recovery time: 24 ±2 hours</p> | <p>Dissolution of the end face plating shall not exceed 25% of the length of the edge concerned</p> <hr/> <p>&lt;General purpose series&gt;</p> <p>ΔC/C</p> <p>Class2:</p> <p>X5R: ±10%</p> <p>&lt;High Capacitance series&gt;</p> <p>ΔC/C</p> <p>Class2:</p> <p>X5R: ±10%</p> <hr/> <p>D.F. within initial specified value</p> <p>R<sub>INS</sub> within initial specified value</p> |
| Solderability                | 4.10                    | <p>Preheated the temperature of 80 °C to 140 °C and maintained for 30 seconds to 60 seconds.</p> <p>1. Temperature: 235±5°C / Dipping time: 2 ±0.5 s</p> <p>2. Temperature: 245±5°C / Dipping time: 3 ±0.5 s (lead free)</p> <p>Depth of immersion: 10mm</p>   | <p>The solder should cover over 95% of the critical area of each termination</p>  |
| Rapid Change of Temperature  | IEC 60384-21/22<br>4.11 | <p>Preconditioning: 150 +0/-10 °C for 1 hour, then keep for 24 ±1 hours at room temperature</p> <p>5 cycles with following detail:<br/>30 minutes at lower category temperature<br/>30 minutes at upper category temperature</p> <p>Recovery time 24 ±2 hours</p>  | <p>No visual damage</p> <hr/> <p>&lt;General purpose series&gt;</p> <p>ΔC/C</p> <p>Class2:</p> <p>X5R: ±15%</p> <p>&lt;High Capacitance series&gt;</p> <p>ΔC/C</p> <p>Class2:</p> <p>X5R: ±15%</p> <hr/> <p>D.F. meet initial specified value</p> <p>R<sub>INS</sub> meet initial specified value</p>   |

| TEST                               | TEST METHOD | PROCEDURE  | REQUIREMENTS  |
|------------------------------------|-------------|--|---|
| Damp Heat with U <sub>r</sub> Load | 4.13        | <p>1. Preconditioning, class 2 only:<br/>150 +0/-10 °C /1 hour, then keep for 24 ±1 hour at room temp</p> <p>2. Initial measure:<br/>Spec: refer to initial spec C, D, IR</p> <p>3. Damp heat test:<br/>500 ±12 hours at 40 ±2 °C;<br/>90 to 95% R.H. 1.0 U<sub>r</sub> applied</p> <p>4. Recovery:<br/>Class 2: 24 ±2 hours</p> <p>5. Final measure: C, D, IR</p> <p>P.S. If the capacitance value is less than the minimum value permitted, then after the other measurements have been made the capacitor shall be preconditioned according to "IEC 60384 4.1" and then the requirements shall be met.</p> <p>* General product:<br/>0201 &lt; 100nF<br/>0402 &lt; 1uF<br/>0603 &lt; 2.2uF<br/>0805, 1206, 1210 &lt; 4.7uF</p> <p>* High cap product:<br/>0201 ≥ 100nF<br/>0402 ≥ 1uF<br/>0603 ≥ 2.2uF<br/>0805, 1206, 1210 ≥ 4.7uF</p> | <p>No visual damage after recovery</p> <p>&lt;General purpose series&gt;</p> <p>ΔC/C</p> <p>Class2:<br/>X5R: ±15%</p> <p>D.F.</p> <p>Class2:<br/>X5R:</p> <p>≤ 16V: ≤ 7% or 2 x initial value whichever is greater</p> <p>≥ 25V: ≤ 5% or 2 x initial value whichever is greater</p> <p>R<sub>ins</sub></p> <p>Class2:<br/>X5R: ≥ 500 MΩ or R<sub>ins</sub> × C<sub>r</sub> ≥ 25s<br/>whichever is less</p> <p>&lt;High Capacitance series&gt;</p> <p>ΔC/C</p> <p>Class2:<br/>X5R: ±20%</p> <p>D.F.</p> <p>Class2:<br/>X5R: 2 x initial value max</p> <p>R<sub>ins</sub></p> <p>Class2:<br/>R<sub>ins</sub> × C<sub>r</sub> ≥ 5s<br/>whichever is less</p> |



| TEST          | TEST METHOD          | PROCEDURE  | REQUIREMENTS   |
|---------------|----------------------|--|--|
| Endurance     | IEC 60384-21/22 4.14 | <p>1. Preconditioning, class 2 only:<br/>150 +0/-10 °C /1 hour, then keep for 24 ±1 hour at room temp</p> <p>2. Initial measure:<br/>Spec: refer to initial spec C, D, IR</p> <p>3. Endurance test:<br/>Temperature: X5R: 85 °C<br/>Specified stress voltage applied for 1,000 hours:<br/>Applied 2.0 × Ur for general product*.<br/>Applied 1.5 × Ur for high cap. product*.<br/>Applied 1.0 × Ur for high cap. product*.</p> <p>4. Recovery time: 24 ±2 hours</p> <p>5. Final measure: C, D, IR</p> <p>P.S. If the capacitance value is less than the minimum value permitted, then after the other measurements have been made the capacitor shall be preconditioned according to "IEC 60384 4.1" and then the requirements shall be met.</p> <p>* General product (Applied 2.0 × Ur):<br/>0201 &lt; 100nF<br/>0402 &lt; 1uF<br/>0603 &lt; 2.2uF<br/>0805, 1206, 1210 &lt; 4.7uF</p> <p>* High cap product (Applied 1.5 × Ur):<br/>0201 ≥ 100nF<br/>0402 ≥ 1uF<br/>0603 ≥ 2.2uF<br/>0805, 1206, 1210 ≥ 4.7uF</p> <p>* High cap product (Applied 1.0 × Ur):<br/>0201: 100nF/25V, 2.2uF to 4.7uF<br/>0402: 4.7uF to 22uF<br/>0603: 4.7uF/25V, 10uF/10V to 25V, 22uF to 47uF<br/>0805: 10uF/ 25V, 50V, 22uF to 100uF<br/>1206: 10uF/ 50V</p> | <p>No visual damage</p> <hr/> <p><b>&lt;General purpose series&gt;</b><br/>           ΔC/C<br/>           Class2:<br/>           X5R: ±15%<br/>           D.F.<br/>           Class2:<br/>           X5R:<br/>           ≤ 16V: ≤ 7% or 2 × initial value whichever is greater<br/>           ≥ 25V: ≤ 5% or 2 × initial value whichever is greater<br/>           R<sub>ins</sub><br/>           Class2:<br/>           X5R: ≥ 1,000 MΩ or R<sub>ins</sub> × C<sub>r</sub> ≥ 50s<br/>           whichever is less</p> <p><b>&lt;High Capacitance series&gt;</b><br/>           ΔC/C<br/>           Class 2:<br/>           X5R: ±20%<br/>           D.F.<br/>           Class 2:<br/>           X5R: 2 × initial value max<br/>           R<sub>ins</sub><br/>           Class 2:<br/>           R<sub>ins</sub> × C<sub>r</sub> ≥ 10s<br/>           whichever is less</p> |
| Voltage Proof | 4.6                  | <p>Specified stress voltage applied for 1~5 seconds</p> <p>Ur ≤ 100 V: series applied 2.5 Ur<br/>100 V &lt; Ur ≤ 200 V series applied (1.5 Ur + 100)<br/>200 V &lt; Ur ≤ 500 V series applied (1.3 Ur + 100)<br/>Ur &gt; 500 V: 1.3 Ur<br/>Ur ≥ 1000 V: 1.2 Ur</p> <p>Charge/Discharge current is less than 50 mA</p>  | No breakdown or flashover  |

**REVISION HISTORY**

| REVISION   | DATE          | CHANGE NOTIFICATION | DESCRIPTION   |
|------------|---------------|---------------------|---|
| Version 26 | Mar. 26, 2020 | -                   | - Capacitance range updated for 0201/0805/1206, 0201 D.F spec update, 1210 dimension update   |
| Version 25 | Jun. 2, 2017  | -                   | - I,R spec updated  |
| Version 24 | Mar. 6, 2017  | -                   | - 0805 L4 spec updated  |
| Version 23 | Nov. 15, 2016 | -                   | - Dimension updated   |
| Version 22 | Oct. 3, 2016  | -                   | - Dimension and Soldering recommendation updated  |
| Version 21 | Jan. 28, 2016 | -                   | - Tests and requirements updated  |
| Version 20 | Dec. 04, 2015 | -                   | - Size updated  |
| Version 19 | Apr. 09, 2015 | -                   | - Voltage updated   |
| Version 18 | Jul. 07, 2014 | -                   | - Voltage updated   |
| Version 17 | Mar. 31, 2014 | -                   | - Test condition updated  |
| Version 16 | Nov. 29, 2012 | -                   | - Test condition updated  |
| Version 15 | Sep. 03, 2012 | -                   | - Test condition updated  |
| Version 14 | May 16, 2012  | -                   | - Product range updated   |
| Version 13 | May 02, 2012  | -                   | - Product range updated   |
| Version 12 | Feb 10, 2012  | -                   | - Product range updated   |
| Version 11 | Oct 21, 2011  | -                   | - Product range updated   |
| Version 10 | Jun 21, 2011  | -                   | - Product range updated   |
| Version 9  | Mar 23, 2011  | -                   | - Product range updated   |
| Version 8  | Jan 25, 2011  | -                   | - Rated voltage of 0201 extend to 50V   |
| Version 7  | Jan 05, 2011  | -                   | - Product range updated   |
| Version 6  | Jul 27, 2010  | -                   | - Dimension on 0603 and 1206 case size updated  |
| Version 5  | Apr 21, 2010  | -                   | - The statement of "Halogen free" on the cover added<br>- Dimension updated   |
| Version 4  | Jan 13, 2010  | -                   | - Thickness updated   |
| Version 3  | Aug 17, 2009  | -                   | - Dimension updated   |
| Version 2  | Jun 09, 2009  | -                   | - Ordering code updated   |
| Version 1  | May 15, 2009  | -                   | - Product range updated   |
| Version 0  | Apr 15, 2009  | -                   | - New datasheet for general purpose and high capacitance X5R series with RoHS compliant<br>- Replace the "6.3V to 50V" part of pdf files: UP-X5R_X7R_HighCaps_6.3-to-25V_1 I, UY-X5R_X7R_HighCaps_6.3-to-25V_1 I<br>- Combine 0201 from pdf files: UP-NP0X5RX7RY5V_0201_6.3-to-50V_2 and UY-NP0X5RX7RY5V_0201_6.3-to-50V_2<br>- Define global part number<br>- Description of "Halogen free compliant" added<br>- Test method and procedure updated |